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POISONOUS MUSHROOMS

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Considerable attention has been given in these pages to edible species of mushrooms, but very little has been said about poisonous species. This is partly due to the small percentage of the latter as compared with the edible and harmless kinds, and partly to the very inadequate knowledge we have of the poisons contained in mushrooms.

The purpose of the present article is to give a general introduction to the subject and to outline the problems to be solved, with the hope that observations and experiments will be made which will contribute to a more accurate and more practical knowledge of the poisonous species native to this country. In the near future, it is our intention to reproduce in this journal several of these species in their natural colors, and to accompany them with descriptions and notes regarding their chemical composition and their physiological effects on the animal system.

Considering its importance, it is remarkable how little is really known about this subject; and the statements and opinions of various authors are so conflicting that one often does not know what to believe regarding the commonest and best known forms. Most of the literature centers about two species, *Amanita muscaria* and *Amanita phalloides,* which, owing to their abundance, wide distribution, conspicuous appearance, and deadly qualities, have been the chief causes of death from mushroom eating the world over. The clinical side of the subject is an old one, but

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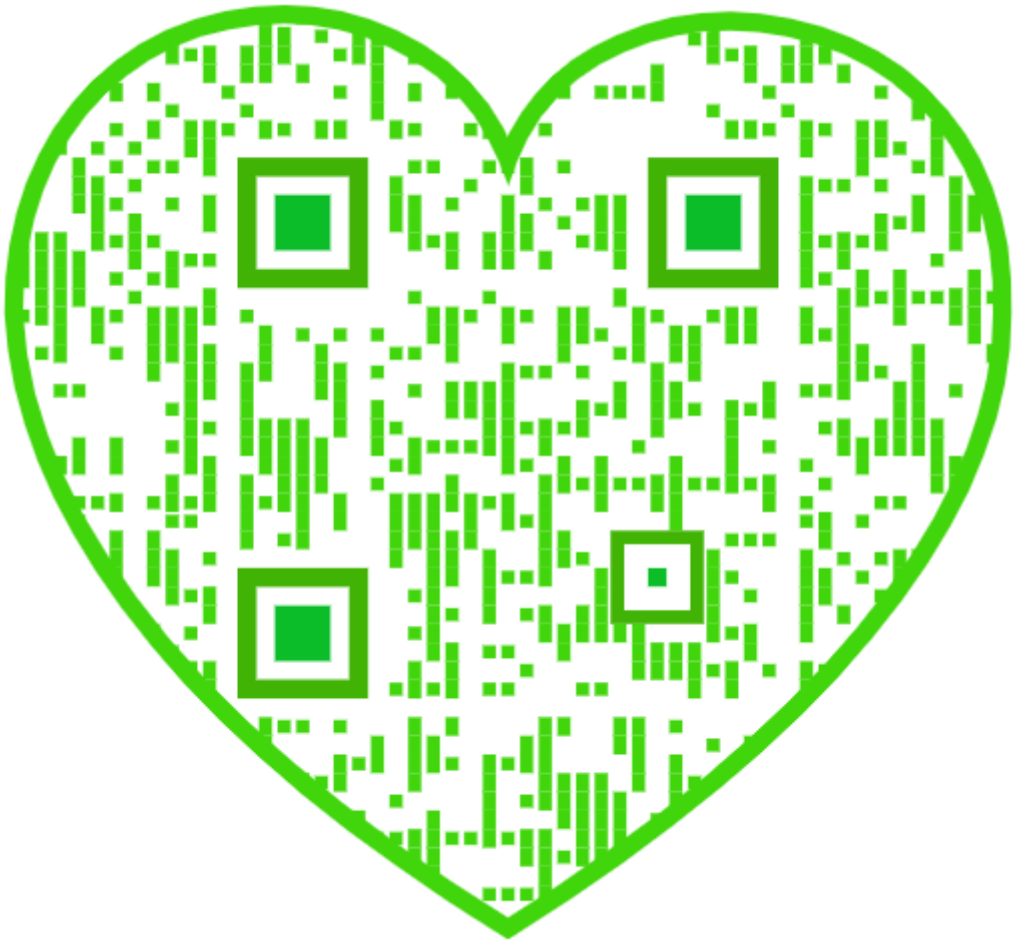

EDIBLE MUSHROOMS IN FRANCE

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careful chemical investigation into the causes of the effects observed dates back only about two decades, being dependent upon the development of modern methods in organic chemistry.

As the use of mushrooms in this country for food becomes more general, the practical importance of this subject will be vastly increased, and it may be possible to discover perfect antidotes or methods of treatment which will largely overcome the effects of deadly species. This would be a great boon even at the present time, and there will always be children and ignorant persons to rescue from the results of their mistakes. Another very interesting field, both theoretical and practical in its scope, is the use of these poisons in minute quantities as medicines, as has been done with so many of the substances extracted from poisonous species of flowering plants, and even from rattlesnakes and other animals. Thus far, only one of them, the alkaloid muscarine, has been so used.

The poisons found in flowering plants belong chiefly to two classes of substances, known as alkaloids and glucosides. The former are rather stable and well known bases, such as aconitine from aconite, atropine from belladonna, nicotine from tobacco, and morphine from the poppy plant. Glucosides, on the other hand, are sugar derivatives of complex, unstable, and often unknown composition, such as the active poisons in digitalis, hellebore, wistaria, and several other plants.

The more important poisons of mushrooms also belong to two similar classes, one represented by the alkaloid muscarine, so evident in *Amanita muscaria,* and the other by the deadly principle in *Amanita phalloides,* which is known mainly through its effects. Besides these, there are various minor poisons, usually manifesting themselves to the taste or smell, that cause local irritation and more or less derangement of the system, depending upon the health and peculiarities of the individual.

The history of mushroom poisoning reaches back to Babylonia and ancient Rome, and every year since then has added to the list of victims, many of whom have been persons of importance. In some cases, poisonous species were used in committing murder. The annual number of deaths in the United States due to mistaking poisonous species for edible ones is probably fifty or more, many of which are not reported.

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The characters and tests used to distinguish poisonous mushrooms have been most varied and curious, and nearly always mixed with queer traditions and superstitions. If the percentage of deadly forms were not so small, probably not over one per cent., the fatalities from this source would have undoubtedly been much more numerous. The only safe rule to follow is the one used with other plants, namely, to know each species accurately before eating it. Even the rules carefully formulated by mycologists are almost certain to prove unreliable as men grow bolder and attempt to eat species not previously tested, because everything that is known in this field has been discovered by experiment, and predictions or generalizations of any kind are both unscientific and unsafe. It may be possible to forecast accurately the discovery of a new chemical element with given properties, but mushrooms have not yet been reduced to that basis. The sweeping statement that brown-spored and black-spored species are always safe was only recently controverted by the accidental discovery of the poisonous properties of *Inocybe infida*. The genus *Amanita,* while including the principal deadly species, contains also many that are widely used as food, the differences often being so slight as to be overlooked by experienced collectors.

The genus *Amanita* is distinguished from other white-spored genera by the presence of a universal veil which encloses the entire sporophore in its young stage and remains either at the base of the stipe or as warts on the surface of the pileus when the sporophore is mature. Over thirty American species are listed, but hardly half of them are worthy of the rank, and only five of these are known to be poisonous. The other species mentioned in the following discussion belong to various and widely different genera.

Discomycetes

Most of the cup-fungi that are large enough to be called "mushrooms" are edible, only one conspicuous species, *Gyromitra esculenta,* having a questionable reputation, and this only in old or decaying specimens, which have been found to contain helvellic acid, a deadly poison similar to that occurring in *Amanita phalloides.* Although young and fresh specimens of *Gyromitra esculenta* have been frequently eaten without harm, it is wise to refrain from using the plant for food in any form.

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Hymenomycetes

This group comprises tremelline forms, such as *Tremella* and *Auricularia;* fleshy, coral-like forms, such as *Clavaria* and *Sparassis;* thin, tough forms with smooth hymenium, such as *Thelephora* and *Stereum;* fleshy or woody forms with spiny hymenium, such as *Hydnum* and *Odontia;* tough or wood-loving forms with porous hymenium, such as *Polyporus* and *Fomes;* fleshy, terrestrial forms with porous hymenium, such as *Boletus* and *Ceriomyces;* and tough or fleshy forms with true gills, such as *Agaricus* and *Amanita.* In all of these divisions except the last two, the species are usually considered either harmless or too tough for food. One woody species of polypore, *Fomes Laricis,* contains a poison and is used in medicine. The poisonous or suspicious species of the Boletaceae and the Agaricaceae will now be taken up in alphabetical order and their poisonous properties discussed.

It must be clearly understood, however, that this list does not contain all the poisonous mushrooms in America. The only safe method of procedure for the mycophagist is to have two lists, one of species to avoid, and another of species that have been thoroughly tested and found safe under all conditions. The accompanying illustrations are made from colored charts published some years ago in France, intended to give popular instruction in distinguishing poisonous and edible mushrooms. Excellent charts of this kind have also been known for many years in Sweden, owing to the work of Elias Fries at Upsala. Regarding these charts, it must be remembered, first, that they soon get out of date, and, second, that the person using them should have a good general knowledge of the characters of mushrooms, otherwise there will be mistakes, which may sometimes prove fatal, especially in distinguishing the species of *Amanita.* In the case of this genus, I would strongly advise everyone to let all of its species severely alone, so far as eating them goes, and thus eliminate many chances of error.

BOLETACEAE

CERIOMYCES FERRUGINATUS (Batsch) Murrill

Considered slightly poisonous by most mycologists, but MacIlvaine claims that it loses its peppery taste on cooking and becomes perfectly harmless.

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CERIOMYCES MINIATO-OLIVACEUS (Frost) Murrill

Poisonous to some and harmless to others. A case of poisoning by this species was reported by Collins in Rhodora for 1899.

SUILLELLUS EASTWOODIAE Murrill.

Properties unknown, but belonging to a suspicious genus.

SUILLELLUS FROSTII (Russell) Murrill

Usually viewed with suspicion because of its red hymenium, but its properties are not accurately known.

SUILLELLUS LURIDUS (Schaeff.) Murrill

Avoided by most persons and said to contain a small amount of muscarine or closely allied alkaloid, as well as choline, but eaten by others for many years without harmful effects, both in this country and in Europe. Owing to the variety of its forms, it is liable to be confusing unless one uses the red tube-mouths as a distinguishing character and avoids the whole genus, which is the wisest thing to do until its species are more thoroughly tested.

SUILLELLUS MORRISII (Peck) Murrill

Properties unknown. Taste mild, but the species, which is very rare, needs to be tested.

SUILLELLUS RUBINELLUS (Peck) Murrill

Properties unknown. Taste mild, but the species needs to be tested.

TYLOPILUS FELLEUS (Bull.) P. Karst.

Usually intensely bitter, both raw and cooked, and therefore inedible, but not generally considered poisonous.

AGARICACEAE

AMANITA COTHURNATA Atkinson

This species was collected in quantity in Virginia during the past summer for investigation. While drying the fresh sporophores in the sun, hundreds of flies were attracted to their viscid surfaces and were paralyzed in great numbers after sucking the juice, thus indicating a close relationship with *A. muscaria.*

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AMANITA MUSCARIA L.

One of the most deadly mushrooms, celebrated for centuries on account of its poisonous properties, due to the alkaloid muscarine, which affects the ganglia controlling the nerves of the heart and thus retards and finally stops its action, if taken in sufficient quantity. Atropine has the opposite effect on the heart, and has therefore been successfully used as an antidote for muscarine. It is said that daturine, the alkaloid from *Datura Stramonium,* is sometimes used for this purpose instead of atropine.

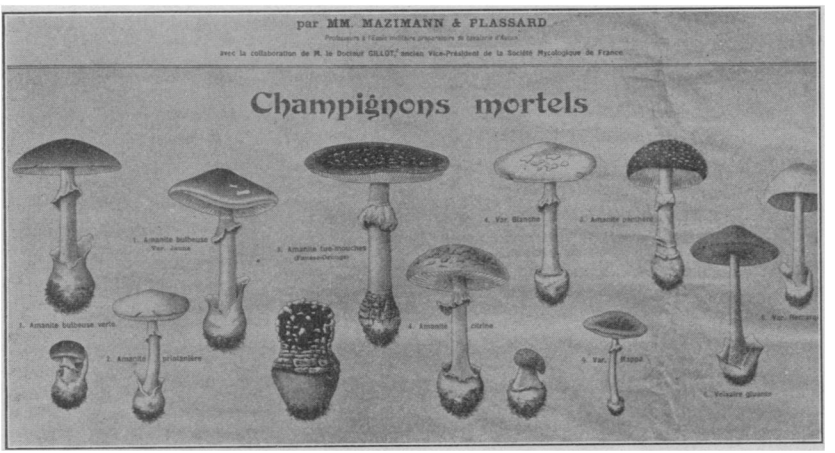

FIG. 1. French chart showing deadly poisonous species.

The literature of this species is more extensive than that of all other poisonous species combined. It lacks the death-cup and must be carefully distinguished taxonomically; it has been generally used as a fly-poison, and also as an exhilarant in certain parts of Russia; it is celebrated in history because of its long and distinguished list of victims; it has been chemically analyzed more often and more successfully than any other species; and an antidote for its principal poison has been discovered. The writings of Palmer, Mendel, MacIlvaine, Carter, Gibson, Atkinson, Clark, Coville, Chestnut, Peck, Herbst, Kobert, Zellner, Esser, Ford, and others contain many interesting details regarding this species.

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AMANITA PANTHERINA DC.

Considered poisonous by all authors, causing intoxication similar to that caused by *A. muscaria,* though in milder form, and containing both muscarine and choline. It is said to be the chief poisonous mushroom of Japan, but has rarely been known to be fatal.

AMANITA PHALLOIDES Fries

This most deadly species, for which no antidote is known, occurs in many forms and colors, but is always characterized by the presence of a prominent death-cup at the base of the stipe. The principal poison is not accurately known chemically, neither have its exact effects on the animal system been determined, although it has been much investigated both by physiologists and chemists. For the rather extensive literature of the subject, the reader is referred to the authors cited under *Amanita muscaria.* It is reasonable to expect that at no very distant date an antidote will be discovered for the deadly amanita, as has been the case with rattlesnake poison and the toxin accompanying diphtheria.

AMANITA STROBILIFORMIS Villad.

This species, according to Ford, contains a small quantity of the deadly poison found in *A. phalloides* and should never be eaten, although claimed by some authors to be harmless. Owing to the present confusion regarding the limitation of species closely related to *A. strobiliformis,* it is wise to suspect the whole group until better known.

CHANTEREL ALECTOROLOPHOIDES (Schaeff.) Murrill

This species, usually known as *Cantharellus aurantiacus* Fries, has been recently investigated, along with *C. tubaeformis,* by Sartory, who pronounces both of them harmless.

CLITOCYBE ILLUDENS Schw.

Pronounced poisonous, though not fatal, by all mycologists who have tested it. Dr. Farlow reported a severe case of poisoning from it in *Rhodora* in 1899. It causes nausea and is soon rejected by all but the strongest stomachs.

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ENTOLOMA GRANDE Peck

This species is suspected, possibly on account of the two poisonous European species, *E. lividum* and *E. sinuatum*. It is well to avoid all of our species until thoroughly tested.

HEBELOMA FASTIBILE Fries

Considered poisonous by some, possibly owing to its pungent taste and odor. One or two species of the genus have a bad reputation in Europe. *Hebeloma* is very closely related to the genus *Inocybe*.

INOCYBE INFIDA Peck

An account of the poisonous effects of this species was published in MYCOLOGIA for September, 1909. It has since been col-

FIG. 2. French chart showing species considered dangerous.

lected in large quantities and is now being investigated by Dr. W. J. Gies and his assistants.

LACTARIA

Many species of this genus were formerly considered poisonous on account of their acrid taste, but, since it has been found that these peppery, resinous substances are usually decomposed on cooking, it will be necessary to make an experimental revision of the genus. *Lactaria rufa* seems to enjoy the worst reputation,

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from all accounts, while *L. torminosa, L. fuliginosa, L. vellerea, L. pyrogala,* and *L. theiogala* are either pronounced poisonous or suspicious by most authors. Care should be exercised in collecting members of this genus for the table.

LEPIOTA MORGANI Peck

This species, which occurs rather abundantly from Indiana to Kansas and south to Texas, may be readily distinguished from *Lepiota americana* and other species of the genus by its green spores. It is harmless to some persons but poisonous to others, though never fatal. Old specimens appear to contain more poison than young ones.

MARASMIUS PERONATUS Fries

Considered slightly poisonous to some persons. It occurs in woods and is sufficiently distinct from *M. oreades* to avoid confusing the two. It is probably only a form of *M. urens.*

MARASMIUS URENS Fries

This species, long considered slightly poisonous, grows in pastures and should be carefully distinguished from *M. oreades.*

PANAEOLUS CAMPANULATUS Fries

A century ago this species was reported poisonous, inducing sleep. MacIlvaine has tried it in small quantities without harmful results.

PANAEOLUS PAPILIONACEUS Fries

Said to produce hilarity and a mild form of intoxication if eaten in quantity.

PANUS STYPTICUS Fries

Extremely astringent and disagreeable, and considered poisonous by all authors. Some say that it is a violent purgative. On account of its small size and apparently tough consistency, few persons would think of eating it.

RUSSULA

It seems to be pretty well established for the American species of this genus that have been investigated that all having an agree-

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able taste and odor are harmless; but the distinctions between species are so slight that it is usually necessary to test each individual specimen before cooking it. *Russula emetica* is poisonous, containing choline, pilzatropine, and probably muscarine; *R. foetens* is also poisonous, but in a lesser degree; while *R. nitida, R. fragilis,* and other species belong to the mildly poisonous or suspected class. No experiments will be of great value until the genus is better known botanically.

TRICHOLOMA SULFUREUM Fries

This species has a strong and disagreeable odor and is considered poisonous by some authors.

VOLVARIA

One species is classed among the very poisonous mushrooms by some European authors, and rosy-spored species in general have long been suspected and avoided by many persons.

Gasteromycetes

Remarkably little is definitely known regarding the properties of the phalloids, the only suspected group of the gasteromycetes. It seems that the strong and very disagreeable odor of many of these plants has discouraged experimentation in this line, and certainly no one would use them for food unless by mistake. *Phallus impudicus, Dictyophora duplicata, Clathrus cancellatus,* and other species have been usually considered poisonous. MacIlvaine has tested the eggs of a few species and found them harmless, while mature specimens are said to be uniformly fatal to swine. Esser suggests that the sporogenous tissue develops the poison, but this would be strange in view of the fact that the very purpose of this tissue with its peculiar odor is to attract flies, which devour it without harmful results. This group, like so many others, only emphasizes the need of much careful investigation before our knowledge of poisonous mushrooms will be anything like complete.

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